

## DIVISION 2 – SITEWORK

### SECTION 02533

#### FORCE MAIN

## PART 1 - GENERAL

### 1.1 DESCRIPTION

- A. Section Includes: Requirements to provide buried HDPE force main, piping and appurtenances, and PVC piping as called for on the plans.

### 1.2 REQUIREMENTS FOR MANUFACTURERS AND SUPPLIERS BEFORE DELIVERY

- A. Sample, inspect, test, and retest pipe, valves, fittings, and joint material.
  - 1. Engineer may inspect sample and test pressure pipe and fittings as specified herein.
    - a. If any specimen fails to meet requirements set forth herein and in referenced ASTM Standards, Engineer will randomly select and test another section of pipe or fitting from same production run of pipe or fitting originally tested.
    - b. Failure of additional samples to meet referenced requirements shall be cause for rejection of remainder of that production run.

### 1.3 SUBMITTALS

- A. The CONTRACTOR shall submit the following items. Furnish a minimum of eight (8) copies to the ENGINEER and one (1) copy to the OWNER.
  - 1. Pipe manufacturer's shop drawings describing pipe materials to be furnished so as to verify compliance with the specifications including installation instructions for the following pipe materials:
    - a. Polyvinyl chloride (PVC) pipe with solvent cement and push-on joints.
    - b. High Density Polyethylene (HDPE) pipe with butt fusion, socket fusion, saddle fusion and electrofusion jointing techniques and flange joints.
  - 2. Fittings: Letter from pipe manufacturer giving brand name of compatible fittings offered with pipe.

#### B. Submission of Data

Furnish copies of shop drawings, catalog data sheets or such other data necessary to fully describe and substantiate compliance with the specifications shall be submitted for all equipment and materials in accordance with the General Conditions. The Contractor shall submit a complete list of equipment to be furnished, giving Manufacturer's name and catalog number for each item. Intent to furnish the exact make named for any item does not relieve the Contractor of this responsibility. If a submittal of this list is not made, the Engineer reserves the right

to make a full selection of equipment, which shall be final and binding, and shall be furnished without additional cost to the Owner. Submittal data for all related equipment shall be submitted at one time.

C. Submit before delivery of materials.

1. Certificates of Compliance for the following items
  - a. Pipe
  - b. Valves
  - c. Fittings
  - d. PVC pipe solvent cements.
  - e. Other Contractor furnished material under this section.
  - f. Include the Contract Number, job location, Contractor's name, types asses and strengths of pipe and pipe manufacturer's name.

1.4 HANDLING AND STORAGE

A. Handling: Unload material carefully.

B. Storage:

1. Place or store as close to final point of placement as is practical.
2. Provide adequate means of protecting material from ultra violet degradation and discoloration following manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe and Fittings.

1. General

- a. Pipe of given size and material by same manufacturer.
- b. Clearly mark each pipe length and fitting as required herein.
- c. Produced by extrusion process and homogeneous throughout, free from cracks, holes, foreign inclusions or other defects and uniform in color.
- d. Do not use pipe with blisters, bubbles, cuts, or scrapes on inside or outside surfaces, which damage wall thickness, or other imperfections which impair performance or life of pipe.

2. PVC

a. General.

- 1) Produced from resins following ASTM D1784 for 12454-B, Type 1, Grade 1, and PVC 1120.
- 2) Bearing NSF seal of approval

- 3) Markings
  - a. Legibly mark pipe at intervals of 5 feet maximum with manufacturer's name or trademark, pipe size, PVC cell classification, appropriate legend (PVC SDR-21 ASTM D2241), manufacturer's lot number, date of manufacture, and point of origin.
  - b. Pipe not marked as specified herein will be rejected.
- 4) Do not use pipe and fittings manufactured more than 1 year before date of work-site installation.
- b. Solvent cemented joint, pipe and fittings:
  - 1) Approved manufacturers:
    - a) Charlotte Pipe and Foundry Co.
    - b) Ipex, Inc.
    - c) or equal.
  - 2) Pipe: ASTM D2241, SDR-21 or ASTM D1785, Schedule 40 for working pressure of 200 psi.
    - a.) Bell-end pipe: ASTM D2672
  - 3) Solvent cement: ASTM D2672.
  - 4) 1-1/4-inch PVC couplings for jointing spigot end pie:
    - a) Extruded type having beveled entrance
    - b) Minimum pressure rating of 200 psi for continuous operation at 73.4 degrees F.
  - 5) Elbows, tees, reducers, and adapters: Minimum pressure rating of 200 psi for continuous operation at 83.4 degrees F. Pipe:
  - 6) 1-1/4-inch adaptors: PVC with socket for solvent-cement joint end connections and female threaded-end connection.
  - 7) Fittings: Manufactured or approved by pipe manufacturer for use and compatible with their pipe.
- c. Gasketed joint, pipe and fittings: Integral bell-end PVC pipe or spigot-end double-bell coupling PVC pipe with gasket joints.
  - 1) Approved manufacturers:
    - a) JM Manufacturing Company, Inc.
    - b) PW Eagle.
    - c) Ipex, Inc.
    - d) Diamond Plastics Corporation.

- e) or equal.
- 2) Pipe: ASTM D2241, SDR-21 or ASTM D1785, Schedule 40 for working pressure of 200 psi.
- 3) Joints: ASTM D3139 for push-on joint pipe.
- 4) End connections: Able to withstand thermal expansion and contraction at each joint and resulting in pressure tight seals up to full rating of pipe.
  - a) Rubber ring gasket: ASTM F477, elastomeric ring suitable for long-term contact with sewage.
  - b) Elastomeric gasket lubricant: Supplied by pipe manufacturer or equal.
  - c) Reference mark: Around entire circumference of pipe on spigot ends indicating depth spigots shall be inserted into bells or couplings.
- a) Pipe spigot ends: Beveled to permit proper and easy assembly of joint.
- 5) Couplings for joining spigot end PVC pipe: Furnished by pipe manufacturer.
  - a) Minimum pressure rating: 200 psi.
  - b) Insertion depth of spigot end of pipe in coupling: Controlled by internal PVC mechanical stop in coupling which permits thermal expansion and contraction.
  - c) Coupling method: Allow for half expansion or contraction of each pipe section to be taken up at each end of pipe.
- 6) Fittings:
  - a) Minimum pressure rating of 200 psi for continuous service at 73.4 degrees F and compatible with pipe used.
  - b) Manufactured or approved by pipe manufacturer for use and compatible with their pipe.
  - c). Threaded pipe and fittings: When required including interior piping in air and vacuum valve release assemblies as shown on the Contract Drawing details.
    - (1) Pipe with threaded end connections: Schedule 80 PVC pipe meeting requirements of ASTM D1785 and D2464, approved manufacturers:
      - (a) Charlotte Pipe and Foundry  
Company (1 and 1-1/4 inch only).
      - (b) Or Equal.
    - (2) Thread sealant: Type, which gives watertight seal and permits ease of disassembly. Use Teflon, Fluoroseal, or similar compounds based on tetra fluorethylene resins.

- (3) Fittings: Manufactured or approved by pipe manufacturer for use and compatibility with pipe.
- 7) Flanged joint, pipe, and fittings: If required by the CONTRACTOR and approved by the ENGINEER.
  - a) Flat face flange: secured by solvent welding and meeting requirements of ANSI B/16.1 Class 125.
  - b) Fittings: Manufactured or approved by pipe manufacturer for use and compatibility with their pipe.
  - c) Flange bolts, nuts and washers shall be stainless steel.
- 3. HDPE Pipe: ASTM D3035 or ASTM F714 HDPE pipe including force main from the pump station meter vault valve flange to the receiving manhole as shown on the Contract Drawings.
  - a. General.
    - 1) Material:
      - a) ASTM D3350 cell classification PE345434C.
      - b) Minimum thermal stability: ASTM D3350.
    - 2) Markings: Legibly marked in green to identify as sewer pipe at intervals of 5 feet maximum with manufacturer's name, trademark, pipe size (nominal size and OD base IPS), PE 3408, SDR-7 appropriate legend such as HDPE, ASTM D3035 or ASTM F714, date of manufacture, and point of origin.
    - 3) Pipe not marked as specified herein will be rejected.
  - b. Pipe and fittings, approved manufacturers:
    - 1) CP Chem, Division of Chevron Phillips Chemical Company, LP.
    - 2) Rinker Materials Poly Pipe Division.
    - 3) Or Equal.
  - c. Pipes: Standard Dimension Ratio (SDR) of 7 with corresponding operating pressure of 200 psi, unless noted otherwise.
  - d. Fittings: ASTM D3261, use injected molded fittings with ends suitable for Butt fusion unless otherwise specified.
    - 1) Where fittings are installed in trench, socket fusion, addle/sidewall fusion and electrofusion jointing technique fittings may be used instead of Butt fusion fittings, when approved by Engineer.
    - 2) Socket fusion fittings: ASTM D2683.
    - 3) Saddle/sidewall fusion fittings: ASTM F905.

- 4) Socket and saddle/sidewall fusion fitting supplied by manufacturer of pipe.
  - 5) Electrofusion fittings supplied by Central Plastics Company or equal.
  - 6) Pressure rating of fittings same as adjacent pipe.
- e. Pipe joints:
- 1) Fusion techniques: Unless otherwise noted, use butt fusion joints between pipes or fittings.
    - a) Where jointing of pipe is required in trench, electrofusion or socket fusion jointing techniques may be used instead of butt fusion jointing technique, when approved by Engineer.
    - b) Make electrofusion couplings by computer controlled automatic electrofusion system. Electrofusion consists of couplings containing integral heating source which is computer controlled for time, temperature and jointing pressure for consistent joint.
      - (1) Couplings rated for same pressure as pipe.
        - (a) Build-in identification feature to automatically set fusion times and to include current monitoring feature.
        - (b) Manufactured by Central Plastics Company or equal.
  - 2) Flanged joints: ANSIB/16.1, Class 125 flat face, when required by the CONTRACTOR and approved by the ENGINEER.
    - a) Pressure rating same as adjacent pipe.
      - (1) HDPE flange adapter, supplied by same manufacturer of pipe with butt fusion jointing technique, ductile iron backup rings and bolts, gaskets, nuts and washers, or,
      - (2) HDPE by Flange end fitting, one piece assembly, one end of HDPE pipe with butt fusion jointing technique and other end being steel or brass flange as manufactured by Industrial Pipe Fittings, Inc. or equal. Coat steel flanges internally and externally with fusion bonded epoxy.
  - 3) No threaded or solvent welded/glued HDPE joints permitted.

## B. Valves

### 1. Ball Valves:

- a. 1-1/4 inch through 3-inch diameter: PVC, true union ball valve.
  - 1) Applications: Pressure sewer force main isolation valves, air and vacuum valve release assemblies, and emergency connector valves as shown on the Contract Drawings.
  - 2) Rating and Configuration: Water tight shut off and non-shock pressure

rating at 73 degrees F, not less than 150 psi. Valve size same as pipeline nominal size. Furnish with socket type end connectors for solvent welding to buried PVC pipelines or female treaded ends for connection to Schedule 80 threaded piping in the air and vacuum valve release assemblies.

- 3) Port: Round through body and ball. Diameter within plus 0.100 inches and minus 0.230 inches of nominal valve size.
  - 4) PVC Components: Valve body, ball, stem seat carriers and union nuts of molded PVC conforming to ASTM D-1784, Cell Classification 12454.
  - 5) Seats: Teflon® PTFE (polytetrafluoroethylene).
  - 6) Stem seals and O-rings: Viton® (fluoroelastomer).
  - 7) Operation Nut: Quarter turn with positive stops. Furnish with 2-inch square operating nut as shown on the Contract Plan Details. Operating nut of anodized aluminum or solid PVC retained with factory installed stainless steel screw threaded into valve stem.
  - 8) Approved models and manufacturers:
    - a) Duo-Bloc 21 by Asahi-America with specified optional construction.
    - b) 2000 Industrial Series by Spears Manufacturing.
    - c) Or equal.
- b. End Connections: The Contractor shall verify in the valve shop drawing submittal that all valve end connections are compatible with the proposed piping furnished.
2. One inch Diameter Sewage Air/Vacuum Valves.
- a. General:
    - 1) Locations as shown on the Contract Drawings
    - 2) Air/Vacuum Release Valves: Same manufacturer for all valves.
    - 3) Usage: Recommended for service up to 150 psi.
    - 4) Bodies and covers: Stainless steel.
    - 5) Include: Complete set of manufacturer-furnished and attached backwash accessories.
      - a) One-half inch diameter inlet with shut-off valve and quick disconnect coupling.
      - b) One inch diameter blowoff outlet with shut-off valve.
      - c) Quick disconnect coupling at air release vent outlet.

- d) Minimum of 5 feet of back flushing hose with quick couplings.
- 6) Approved manufacturers:
  - a) APCO,
  - b) or equal.

C. Connection Appurtenances.

- 1. HDPE Pipe connection appurtenance if needed by the CONTRACTOR and approved for use by the ENGINEER.
  - a. Compression Type Mechanical Couplings: Suitable for joining HDPE to HDPE or HDPE to PVC SDR 21 if needed shall be Dresser Piping Specialties, Style 90 for HDPE by HDPE, 2-inches and smaller, Smith-Blair, Inc., style Maxi-Grip EZ for HDPE by HDPE or style Maxi GripU-series Class I for HDPE by PVC, 4-inches and smaller diameter pipes, or equal.

## PART 3 - EXECUTION

### 3.1 INSTALLING PIPE

A. Trench Method: PVC and HDPE Pipe.

1. General

- a. Inspect exterior and interior of each pipe and fitting for damage and discoloration.
- b. Trench excavation, backfill and test pits: Follow Specifications Section 2 Trench, Excavation and Backfill and as indicated as follows.
  - 1) Before pipe installation:
    - a) Excavate sufficient trench in advance and test pit existing underground utilities/structures, whether shown on Drawings or visually identified in field, to:
      - (1) Verify actual locations.
      - (2) Make reasonable changes in line and grade to resolve conflicts, as approved by Engineer.
    - b) Furnish Engineer location and elevation information when previously unknown or different underground utilities/structures are encountered.
  - 2) Perform additional work made necessary because of failure to take above precautions at no cost to the OWNER.
- c. Pipe Embedment Material for pipe installed by open trench excavation.
  - 1) Place embedment material so that pipe is uniformly supported along its length.



- 2) Do not drop pipe and fittings into trench.
- 3) Do not drag pipe in manner which causes scratching of pipe surface.
- 4) Excessive gouging of pipe surface will be cause for rejection.
- d. Placement.
  - 1) Clean each pipe and fitting of foreign substances before placing in trench and keep clean during jointing process.
    - a) Should foreign substances, harmful materials, or damaged pipe be observed in previously installed pipe, cease work until foreign material is removed or damaged pipe removed and replaced.
  - 2) Close open ends of pipe and fittings with a watertight seal during periods when work is not in progress.
  - 3) Provide thrust blocks at bends, tees, caps, and plugs per the details shown on the Contract Drawings.
- e. Pipe Embedment and Trench Backfill Materials.
  - 1) Provide pipe embedment material around pipe per plan detail.
- f. Install detectable warning tape over the force main. The detectable warning tape shall be green color with six inch width and minimum 5 mils thickness. The tape shall have minimum 3/4 inch high lettering on each line stating "CAUTION - SEWER LINE BURIED BELOW", repeated continuously along length of tape at intervals no greater than 3 feet. Place tape directly over centerline of pipe, between 18 to 30 inches below finished surface and with minimal number of splices. Overlap the tape a minimum 6 inches at splices and intersections..
- g. Perform required pressure test as specified herein.
2. PVC Pipe and Fittings.
  - a. Follow pipe manufacturer's installation instructions for field cutting and beveling PVC pipe and minimum radius of curvature of various sizes of pipe for installing curved sections of pipe.
  - b. Place solvent cement joint pipe in trench as specified herein and following manufacturer's recommendations.
  - c. Provide thrust blocks at bends, tees, caps, and plugs per details shown on the Contract Drawing Force Main Details.
  - d. Remove and replace damaged pipe and fittings at no cost to the Owner.
3. HDPE Pipe and Fittings.
  - a. Follow pipe manufacturer's installation instructions for field cutting and fusion jointing techniques for HDPE pipe. Include acceptable size and shape of fusion bead; and minimum radius of curvature of various sizes of pipe for installing curved sections of pipe.

- b. Do not install flanges, fittings, or valves in curved section.
- c. Use butt fusion jointing technique for connections between pipe sections or fittings, unless otherwise noted herein.
- d. Inspect and evaluate following manufacturer's installation instructions.
- e. Remove and replace damaged HDPE pipe and fittings at no cost to the Owner.

### 3.2 JOINTS

#### A. PVC Pipe and Fittings.

- 1. Push-on Joints: Make push-on joints following manufacturer's instructions.
  - a. Insert spigot ends into bells and couplings to depth marked on pipe.
  - b. If pipe is cut, mark depth reference around entire circumference of pipe.
  - c. Use only lubricant supplied by pipe manufacturer and following manufacturer's directions.
- 2. Threaded Joints: Follow pipe manufacturer's installation instructions

#### B. HDPE Pipe and Fittings.

- 1. Fusion Jointing Techniques: For joints between pipes and/or fittings use butt fusion jointing technique, unless otherwise noted.
  - a. Where jointing of pipe and/or fittings is required in trench, electrofusion or socket fusion jointing techniques may be used instead of butt fusion jointing techniques, when approved by Engineer.
  - b. Make joints following manufacturer's instructions and ASTM D2657.
  - c. Install mechanical couplings following manufacturer's recommended procedure.

### 3.3 FITTINGS AND VALVES

#### A. Install fittings and valves as shown on the Contract Drawings.

- 1. Inspect and operate valves to ensure proper working order prior to installation.
- 2. Set fittings and valves and join pipe as specified previously herein.
- 3. Install valve boxes

#### B. Installation: Set valve boxes at right angles to pipe, centered and plumb over valve operating nut with box cover flush with finished grade or otherwise as directed.

- 1. Support box to maintain nut in position for operation with extended tee wrench operator.
- 2. Backfill and compact under and around valve boxes to ensure no vertical loads are transmitted to valves or pipe.

3. Set pipe and fittings in arch openings of lower box section so that no part of box bears on pipe, fittings, and valves.
4. Where valve box is located in area where the surface is scheduled to be improved, provide marker stake consisting of a piece of 2 inch by 4 inch lumber a minimum of 5 feet long adjacent to valve box with approximately 3 feet extended above ground.

### 3.4 THRUST BLOCKS

- A. Provide thrust blocks on bends, tees, seal-only type mechanical couplings on HDPE pipe, connections between PVC and HDPE pipes, plugs, and caps as shown on the Contract Drawing details for thrust blocks
  1. Ensure that entire face of earth against which thrust block will bear is firm bearing, flat, and at proper angle to counteract thrust.

### 3.5 FIELD TESTING

- A. Perform field pressure tests on pressure sewer force main pipe and connections.
  1. Before Beginning Pressure Test:
    - a. Cure PVC solvent-cement joints and concrete thrust blocks.
    - b. Completely backfill pipe
    - c. Cap or plug ends of test sections and brace caps to withstand thrust developed under test pressure.
    - d. Slowly fill section of pipe to be tested with clean potable water until completely full and air has been expelled.
    - e. HDPE pipe:
      - 1) Before beginning test, pressurize pipe to allow for diametric expansion or pipe stretching to stabilize.
      - 2) Add water as necessary until pressure stabilizes at test pressure.
      - 3) Protect exposed pipe from temperature fluctuation.
  2. Conduct pressure testing with ENGINEER in attendance and give 72 hours notice to ENGINEER prior to testing.
  3. Water meter for testing: Furnished by the CONTRACTOR. All costs for water supplied for testing shall be included in the bid price for piping and shall be at no additional cost to the Owner.
  4. Provide pressure gage recorder capable of printing a continuous record of pressure test readings (by Dickson Pressure Recorders, Model Numbers PW457 or PR81000 or equal) and charts for testing.
  5. Use test pressure of a minimum of 100 psi at low point of system.

6. Subject test section to test pressure for minimum of 2 hours. CONTRACTOR personnel will operate valves during this portion of test under direction of the ENGINEER.
7. Leakage Allowance.
  - a. HDPE pipe with fusion jointing techniques for connections: None allowed.
  - b. PVC gasket joints: Calculate maximum allowable leakage for pipe with gasketed joints using following formula:

$$ND\sqrt{P}$$

$$L = \frac{ND\sqrt{P}}{7400}$$

Where:

L = maximum allowable leakage, gallons/hour

N = number of joints in test section;

D = nominal diameter of tested pipe, inches

P = average test pressure, pounds per square inch.

8. Should test results show displacement, damage, or leakage in excess of allowable amount, repair displacement and damage, eliminate leakage and retest until specified conditions are met, at no cost to the OWNER.
9. After approval of test by ENGINEER open all valves.

#### PART 4 - MEASUREMENT AND PAYMENT

##### 4.1 PRESSURE SEWER FORCE MAIN

- A. Measurement: By linear foot of various sizes and types provided and by the method of installation, measured horizontally along centerline of pipe.
  1. No deductions will be made for lengths of fittings, connections, valves, flushing connections, and air/vacuum valve manholes.
- B. Payment: At unit price listed for each size and type listed in Bid Schedule.

END OF SECTION